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Performance Recovery Following Startle: A Laboratory Approach To The Study OF Behavioral Response To Sudden Aircraft Emergencies

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16. Abstract

This paper deals with the use of response/recovery rate to auditory startle as a laboratory technique for simulating some of the principal aspects of the initial shock phase of sudden emergency situations. It is submitted that auditory startle, with its unexpectedness, pronounced autonomic reaction, fear-like subjective experience, and frequent behavioral disruption, approximates the response pattern to be expected in the initial shock phase of sudden traumatic emergencies, and that by studying the time course of performance recovery following startle, as well as individual differences in response/recovery rate, we may gain a better understanding of some of the variables related to extreme reactions displayed by individuals in real-life emergency situations. Research studies conducted in our laboratory and in others on performance impairment/recovery following startle are reviewed. These studies include those dealing with initial reaction time to the startle stimulus itself, disruption and recovery rate of perceptual-motor (tracking) performance following startle, and the time-course of performance recovery in information processing tasks after exposure to startle. Data are also presented showing a relationship of several individual difference variables to performance response/recovery following startle. These variables include autonomic response to the startle stimulus and level of task proficiency prior to startle.

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PERFORMANCE RECOVERY FOLLOWING STARTLE: A LABORATORY APPROACH TO THE STUDY OF BEHAVIORAL RESPONSE TO SUDDEN AIRCRAFT EMERGENCIES

INTRODUCTION

Aircraft emergencies often occur without prior warning and require rapid response. Although it is commonly accepted that response times to unexpected events generally exceed those to comparable events that are anticipated, actual data on response times to unexpected stimuli or events occurring infrequently in real-life settings are surprisingly sparse. In one of the few studies in which such data were obtained, Warrick, Kibler, and Topmiller (1965) examined the time that it took secretaries to press a button located 9.5 in from their typewriters when the stimulus (buzzer) was sounded without warning once or twice a week over a 6-month period. Relative to alerted conditions, the increase in response times when the buzzer was unannounced was surprisingly small. During the first month, unalerted response times (Mdn=.8 sec) were about 33 percent longer than response times under alerted conditions. By the end of the 6-month period, the median unalerted time was .6 sec, representing only a 22-percent increase over alerted times.

Other studies of response times to unexpected events have been conducted by investigators concerned with driver reactions to simulated emergencies. Muto and Wierwille (1982), for example, found that braking time to an unexpected event, presented after prolonged driving, averaged about 1.64 sec when the event first occurred. By the time the fourth "emergency" occurred, response times were about equal to baseline response times (approximately 1.40 sec). Thus, unexpectedness resulted in braking times that were 23 percent longer, at most, than braking times when the events were anticipated. In a somewhat similar study, Johansson and Rumar (1971) also compared braking response times to expected and unexpected situations. On the average, braking time to unexpected situations averaged .73 sec; this decreased to .54 sec when the events were anticipated. Unexpectedness, thus, resulted in response times that were approximately 35% longer than response times for anticipated events.

A few reported studies have dealt with simulated nuclear power plant emergencies. In these studies, process operators in nuclear control rooms were instructed to respond as rapidly as possible to simulated emergencies signaled by audible alarms and visual indicators. With signal rates of 1.35 to .35 per hour, response times (estimated from the data given) ranged from less than 1 sec to approximately 2.5 sec (Lees and Sayers, 1976).

Of the studies just discussed, those that have compared response times to both expected and unexpected stimuli are relatively consistent in their findings. Maximum percent increase in response time due to the factor of unexpectedness has been found to range from 22 to 35 percent. When the influence of repetition has been examined, reduction in uncertainty caused response times to approximate baseline (alerted) conditions. Such findings lend support to the conclusion reached by Warrick, Kibler, and Topmiller that one may be able to extrapolate to unalerted conditions from data collected under comparable alerted conditions.

In many types of emergency situations, however, one has not only the factor of unexpectedness to contend with, but also the additional and potentially disruptive factor of intense emotional arousal. Actual data with regard to response time to traumatic emergency events, to say nothing of the time-course of behavioral recovery following such experiences, are virtually nonexistent. Part of this is clearly due to the extreme difficulty of creating under controlled, experimental conditions the particular perceptual/cognitive events that, because of their meaning or significance to the individual, are the usual triggers for the emotional reactions associated with real-life emergencies.

RATIONALE FOR THE USE OF STARTLE

A possible technique for circumventing this dilemma involves the use of startle. Before considering this approach, however, a brief review of the startle response is warranted. In essence, the startle reflex is primarily a muscular response where the complete reaction consists of a series of involuntary contractions beginning at the head with the eyeblink and rapidly progressing to the legs. It is typically evoked by impulsive auditory stimuli (e.g., a pistol shot), although other, and generally less effective stimuli, such as a jet of ice water, photoflash, and electric shock have also been found to elicit it (Landis and Hunt, 1939). It always begins within 100 msec of the eliciting stimulus, and may have a duration of .3 sec for a mild but complete response to approximately 1 to 1.5 sec for an intense reaction (Ekman, Friesen, and Simons, 1985; Landis and Hunt, 1939). Although the muscle reflex, described in detail by Landis and Hunt (1939), is often considered to define the startle pattern in its entirety, the total pattern includes physiological as well as subjective components. The physiological response consists of a pronounced, generalized increase in autonomic and central nervous system activity and has been described in detail by Sternbach (1960a). This pattern of physiological response, when compared with autonomic response patterns produced by exercise, the cold pressor test, and injections of epinephrine and norepinephrine, has been found to closely resemble the pattern produced by epinephrine injection (Sternbach, 1960b).

The feeling state evoked by startle is more difficult to classify. While often considered to be related to the emotion of surprise (Ekman, Friesen, and Simons, 1985), others have identified it not only with surprise, but with fear and anger as well (Blatz, 1925; Landis and Hunt, 1939; Skaggs, 1926). Interestingly enough, the epinephrine-like physiological pattern to startle that was noted above is also the characteristic pattern found to be produced by fear-inducing situations (Ax, 1953; Schacter, 1957). Although agreeing that the feeling state associated with startle appears closest to fear and anger, Landis and Hunt (1939) consider that it may be best to define startle as preemotional. They note that "It does not stand in the same group of phenomena as the major emotions, yet it seems to be closely related to them and to belong generically in the same field. It is an immediate reflex response to sudden, intense stimulation which demands some out-of-the-ordinary treatment by the organism. As such it partakes of the nature of an emergency reaction, but it is a rapid, transitory response much more simple in its organization and expression than the so-called 'emotions'" (Landis and Hunt, 1939, p. 153).

In a study concerned with the question of why some individuals seem to "freeze," while others appear to react almost instantaneously in emergency situations, Sternbach (1960a) reasoned that startle resulting from a loud auditory stimulus might be used to approximate the principal components (surprise, fear, intense physiological arousal, and temporary behavioral disruption) that are common to many types of sudden emergencies and hence provide a technique for studying behavioral recovery following traumatic events under laboratory conditions. It is generally accepted that sudden emergencies frequently, if not typically, elicit feelings of fear or anxiety, and, as we have just noted, a number of studies have demonstrated that startle does evoke an experience, albeit rather transitory, that has been identified not only with surprise, but with fear as well. Further, the physiological response to startle, when compared with the autonomic response patterns produced by a number of other stressors, has been found to closely resemble the epinephrine pattern associated with fear-inducing situations. Taken in conjunction with the Landis and Hunt (1939) belief that the total startle pattern resembles that of an emergency reaction, it would not seem unreasonable to believe that studies of response to startle might provide a useful laboratory approach to the study of human behavior in sudden stress situations. The present paper adopts this position and reviews research findings relevant to performance recovery from startle. No attempt is made here to document the methodological considerations (e.g., stimulus parameters, modifying variables, differentiation of startle from orienting and defensive reflexes, measurement requirements) that must be recognized in carrying out research in this area. Relevant methodological considerations are reviewed or described by Graham, 1979; Landis and Hunt, 1939; Ekman, Friesen, and Simons, 1985; Raskin, Kotses, and Bever, 1969, and Thackray, 1972.

RESPONSE TIME TO STARTLE

Using a pistol shot as the stimulus for a required button press response, Sternbach (1965a) found that response times to startle ranged from 128 to 3,262 msec with a mean (estimated from the data) of 950 msec. Sternbach's primary concern, however, was not with establishing the actual range or limits of response time to startle, but rather with investigating psychophysiological correlates of individual differences in time to respond. In this regard, he examined physiological resting and response levels of the 10 fastest and slowest reactors to startle. While there was no meaningful relationship of resting physiological levels to reaction time, fast and slow reactors differed significantly in their physiological response to startle on a number of variables; slow reactors showed a significantly greater increase in systolic blood pressure, pulse pressure, palmar skin conductance, and heart rate than did fast reactors. In addition to greater autonomic response, informal statements made by slow reactors (e.g., "I knew I was supposed to do something, but I couldn't think of it at first." "I thought I pressed it at first, then I realized I hadn't." "It took me a moment to realize what I had to do.") suggested greater cognitive disruption as well; no such statements were made by the group of fast reactors.

A subsequent study by Thackray (1965) extended the Sternbach study by including a comparison of response times to high-intensity, startling stimuli with reaction times to nonstartling auditory stimuli. The principal intent of this investigation was to provide baseline data that might be used to estimate pilot response times to potentially critical situations, such as unexpected clear air turbulence or a sudden failure in an automatic control system. Subjects were instructed to respond to any auditory stimulus by moving a control stick as rapidly as possible to the left and simultaneously flipping back a response button located on top of the stick. The first stimulus consisted of an unexpectedly loud burst of 120-db noise; this was followed by a series of 50 low-intensity auditory stimuli at constant 15 sec intervals and a final 120-db stimulus. The mean (893 msec) and range (356 to 1800 msec) of response times to the initial high-intensity stimulus were similar to those obtained by Sternbach. Like Sternbach, autonomic reactivity to startle was found to be positively correlated with response time to startle. The second high-intensity stimulus presented 15 sec after the series of low-intensity stimuli, and with no indication that anything other than another low-intensity stimulus would occur, yielded a mean (416 msec) and range (187 to 1550 msec) of response times that were considerably lower than that obtained to the first high-intensity stimulus. Interestingly enough, autonomic response to the second loud stimulus was found to be inversely related to response time. Thus, while magnitude of autonomic response to the initial high-intensity sound was directly related to performance disruption, autonomic response to the second, and subjectively less startling sound, was associated with performance facilitation. One might hypothesize that, in accordance with the predictions of activation theory (Malmo, 1959), arousal level to the initial startle was sufficiently high to disrupt performance, while the lower arousal associated with the second startle acted to facilitate performance.

Although positive correlations were found between reaction times to the low-intensity sounds (Mn=368 msec) and response times to the high-intensity, startling stimuli, the most interesting aspect of this finding was that startle appeared to magnify differences between individuals in their reaction times to the low-intensity, nonstartling tones; i.e., slow responders tended to respond even more slowly, while the fast responded more rapidly to startle stimulation.

RESPONSE/RECOVERY OF CONTINUOUS PSYCHOMOTOR PERFORMANCE FOLLOWING STARTLE

While the studies described above provide basic information on the time required to make a discrete, voluntary response to startle, they fail to indicate whether this time frame encompasses all of the disruptive effects of startle or whether some disruption may extend beyond this period. Since the reflex muscle response to startle, depending upon the intensity of the reaction, may last from .3 to 1.5 sec (Landis and Hunt, 1939), it is evident that a major portion of the time required to complete a voluntary response following startle is a direct result of this reflex interference. To provide information on possible disruptive effects of startle beyond this period, Thackray and Touchstone (1970) studied the recovery rate of continuous psychomotor performance following startle. In this study, subjects performed a compensatory tracking task continuously during a 30-min period. A 115-db burst of white noise occurred unexpectedly 2 min into the session and again at the middle of the session. Tracking error during the first min following the initial startle stimulus is shown in Figure 1. Also shown in this figure are the response/recovery curves for heart rate and skin conductance. Although maximum performance disruption occurred during the first 5-sec measurement period following stimulation, significant ($p<.05$) impairment was still present 10 sec after startle.

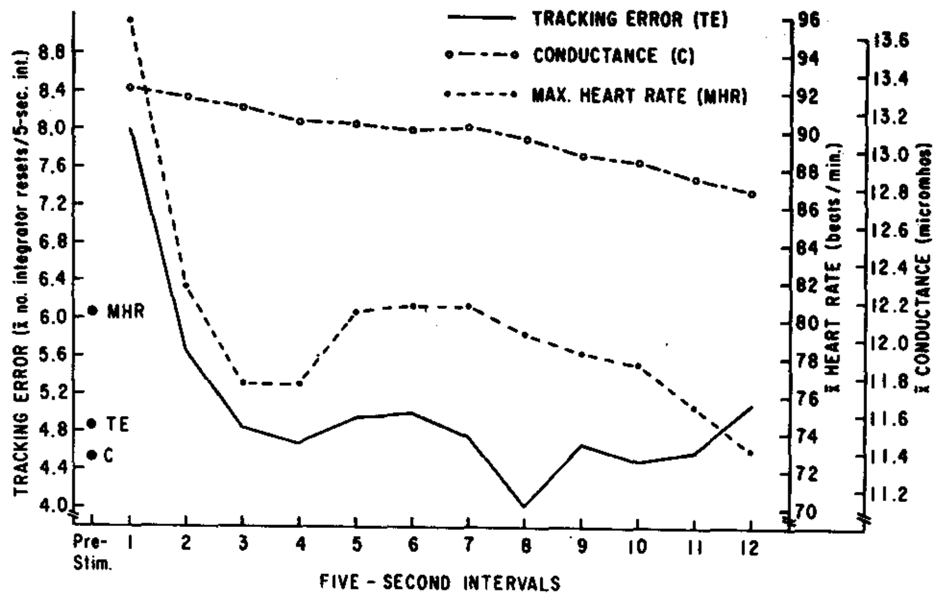

Figure 1. Mean tracking error, maximum heart rate, and conductance level during successive 5-sec intervals following startle. Also shown are pre-startle values for each variable.

The disruption in tracking performance, persisting into the 10-sec period following startle stimulation, clearly extended beyond the initial disruption caused by the reflex response itself and would appear to be a manifestation of a longer lasting, more general physiological/emotional response to the unexpected noise stimulation. Support for this view is suggested by the apparent covariation of heart rate with performance that is shown in Figure 1 and that appears to extend at least into the first 30 sec following stimulation. (Incidently, it is of interest to note in this figure that significant performance improvement occurred during the 8th 5-sec interval following startle; facilitation at this same location also occurred following the second startle stimulus. Since neither of the autonomic measures showed any corresponding change during this time period, some central nervous system facilitory process is suggested.)

The pattern of performance change and physiological response to the second of the two startle stimuli, although of somewhat lower magnitude, was quite similar to that shown in Figure 1. Of interest was the finding that magnitude of tracking error to the two startle stimuli was significantly correlated ($r=.60$, $p<.01$). This enabled us to form two subgroups of subjects whose tracking error following both startle events placed them in either the top third (high impairment) or bottom third (low impairment) of the combined distributions. Relative to prestartle tracking performance, it was found that the high-impairment group almost doubled in their tracking error scores immediately following startle; the low-impairment group showed little difference between their prestartle and poststartle levels of tracking error. With regard to physiological response to startle, the high-impairment group showed significantly greater heart rate acceleration, but the groups did not differ significantly ($p>.05$) in conductance change.

A study by Vlasak (1969) likewise evaluated individual differences in psychomotor disruption to startle. Using a simple line-tracing task, Vlasak studied differences in performance disruption to an unexpected 100-db sound from a Klaxon horn. His findings were similar to those of Thackray and Touchstone (1970); performance impairment following startle was related to prior task proficiency, with less proficient subjects being considerably more disrupted by startle. As noted earlier, Thackray (1965) also found evidence to suggest that, with the particular reaction time task employed, startle tended to exaggerate preexisting differences between individuals in their nonstartle response time; i.e. the slow became slower and the fast responded with even shorter latencies to startle. Taken together, the results of these three studies suggest the general hypothesis that the extent of disruption following startle is dependent upon prestartle level of performance, with the greatest impairment occurring among those who are either slowest or least proficient prior to startle.

Before concluding this section it should be noted that both Vlasak and a subsequent study by May and Rice (1971) found the total duration of tracking impairment following startle to be only 2 to 3 sec, which is considerably less than that found in the Thackray and Touchstone study. In a reexamination of their data, Thackray and Touchstone likewise found maximum impairment to occur within this same time period and concluded that at least some of the disruption that takes place within the 5-sec period following startle is attributable to direct mechanical effects of the muscle reflex on motor control. However, the fact that Thackray and Touchstone found tracking performance to be significantly impaired for up to 10 sec following startle clearly demonstrates that disruptive effects transcend the time period that one might reasonably attribute to mechanical effects of the startle reflex. The longer period of disruption found by Thackray and Touchstone may have been due to the use of a more difficult tracking task and/or the use of a more refined measure of tracking error than was used in either the Vlasak or the May and Rice study.

RECOVERY OF COGNITIVE FUNCTIONING FOLLOWING STARTLE

Although perceptual-motor recovery following startle appears to be quite rapid, there is evidence that tasks involving decision making or information processing may be impaired for a longer period of time. Thus, Vlasak (1969) studied the effects of startle on continuous mental subtraction and found performance to be significantly impaired during the first 30 sec following stimulation. A similar period of impairment was found by Woodhead (1959, 1969), who obtained decrements on a continuous symbol-matching task lasting from 17 to 31 sec after startle. The fact that impairment on some tasks following startle may last for at least 30 sec lends further support to our belief that startle effects may extend considerably beyond the initial period of motor disruption produced by the reflex response itself.

In all of the startle studies just reviewed, however, performance recovery effects were studied only during some portion of the first 60 sec following stimulation. While it is certainly possible that performance impairment does not extend beyond this time period, startle is known to be accompanied by rather pronounced autonomic (especially cardiovascular) changes (e.g., Thackray and Touchstone, 1970, 1983), and it is conceivable that such changes could have more lasting effects on performance. Thus, a pronounced discharge of the autonomic nervous system might have a long-term activating effect leading to performance facilitation, or, conversely, it might produce a period of parasympathetic overcompensation resulting in eventual drowsiness and impaired performance.

In our most recent study (Thackray and Touchstone, 1983), we used monitoring and information processing tasks to examine both short- and long-term performance recovery effects following a simulated emergency situation (a radar failure) that was accompanied by either a startling or a nonstartling auditory signal. The subject's primary task was to monitor a simulated air traffic control (ATC) radar display. One hr into the session a radar failure occurred that was accompanied by either a loud (104 db) or low level (67 db) burst of white noise acting as an alarm signal. Subjects were then required to turn in the chair and begin performing a simple information processing (serial reaction) task. (The serial reaction task consisted of a self-paced, four-choice reaction time task in which the subject pressed one of four keys in response to a centrally displayed number.) Five min of performance on this task was followed by a return to radar monitoring. In addition to performance, physiological and subjective measures of startle and arousal were also obtained. It was hypothesized that performance following the high-intensity alarm signal (expected to elicit a startle reflex) would be significantly impaired relative to performance following the low intensity signal (expected to elicit an orienting-type response).

Heart rate response and subjective ratings of startle were consistent in demonstrating that the high-intensity signal was clearly startling to subjects in this group. Conversely, the group exposed to the low-intensity signal did not rate the signal as startling, and the slight heart rate deceleration that occurred immediately following stimulation was consistent with the expectation that this level of noise would produce only an orienting or surprise reaction (Graham, 1979). In spite of these differences, however, both groups showed almost identical patterns of response during the first min following noise stimulation. Relative to prestimulus performance levels, mean response times on the serial reaction (SR) task were significantly elevated only during the first 6 sec following noise; thereafter, performance returned to prestimulus levels for the remainder of the 60-sec period. A comparison of the response patterns obtained for the two groups is shown in Figure 2.

At first glance, this lack of any difference between the startled and nonstartled groups in mean performance during the first 6 sec following stimulation would appear to be inconsistent with the findings of our previous studies and those of others reviewed earlier. Since these results were not expected, response times during the first 6-sec period were examined more closely. The time from the onset of the noise signal to the first SR response was obtained for each subject. These initial SR response times, which encompass the time required to transition from the radar to the SR task, were plotted on log probability paper and are shown in Figure 3.

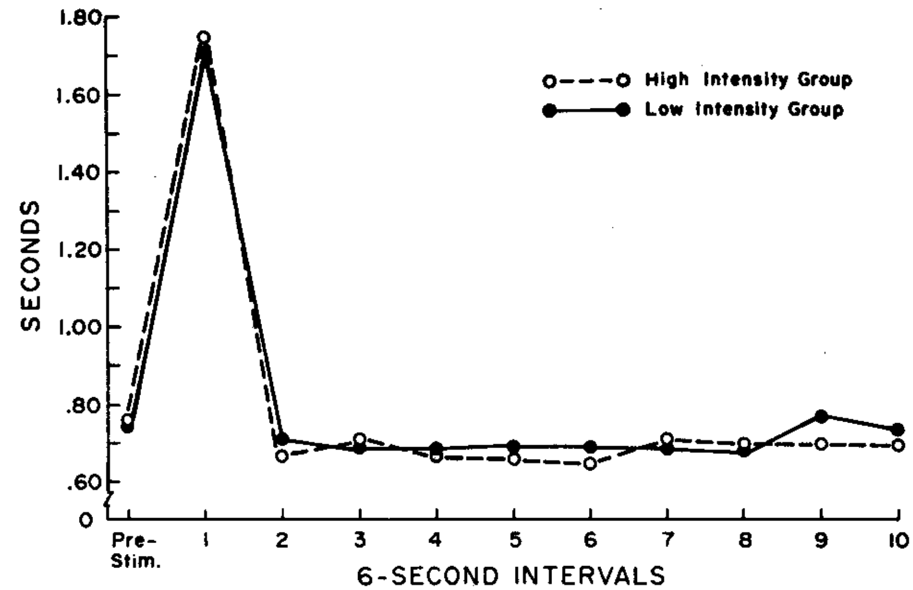

Figure 2. Mean response time for SR performance during successive 6-sec intervals of the first minute following noise stimulation. Also shown are prestimulus values.

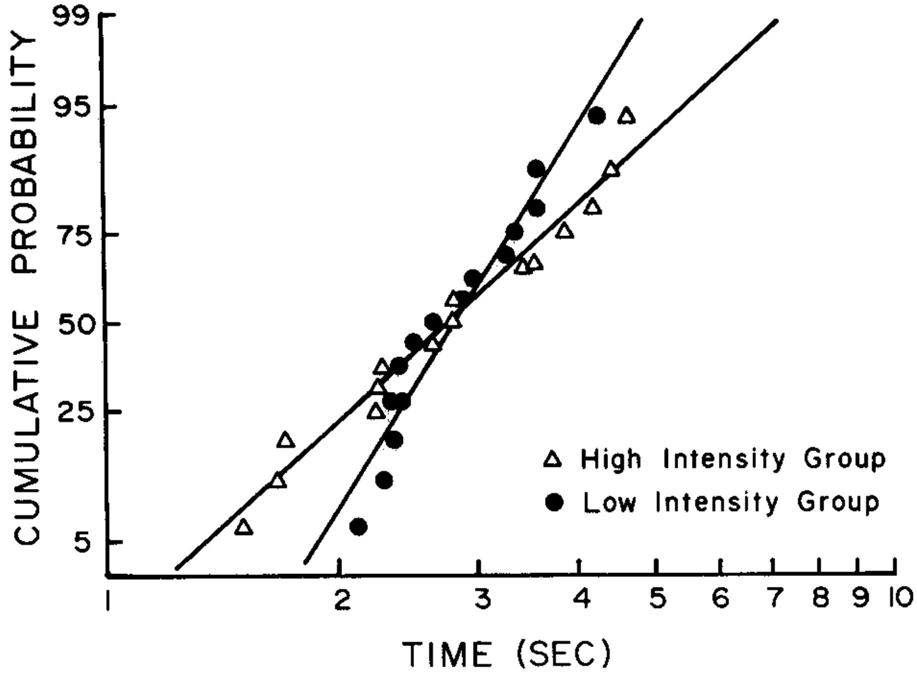

Figure 3. Task transition times for the two groups.

Although mean time to make this initial response (designated task transition time) did not differ among the two groups (2.91 and 2.84 for the means of the high- and low-intensity groups respectively), Figure 3 clearly suggests a difference between the groups in range or variability of transition times. An F test of the variances of the two groups revealed the startled group to be significantly more variable ($F(14/14)=2.61$, $p<.05$) in the time required to make this initial response. An examination of variability of responses on the SR task subsequent to this first response, but still within the first 6-sec period following stimulation, revealed variances of .2869 and .1272 for the high- and low-intensity groups respectively. These values, although in the same direction as the transition time variances, failed to reach significance ($F(14/14)=2.25$, $p>.05$). The difference between groups in response variability was thus confined to task transition time.

Analyses of the video-taped recordings taken during noise stimulation clarified these findings. In the group receiving the nonstartling noise signal, behavior following stimulation was extremely uniform; subjects slowly turned in the chair and began performing the SR task. In the high-intensity (startle) group, there were pronounced individual differences following stimulation with some subjects appearing dazed and confused by the noise while others recovered almost immediately and rapidly began performing the task. The disruptive effect of the loud sound for some subjects combined with the rapid recovery shown by others apparently balanced the generally uniform response of the low-intensity group. This also explained the difference in the variance of response times of the two groups. The increased range or variability of initial response to startle that was found in this study is clearly similar to that discussed earlier in the context of both voluntary reaction time to startle and tracking performance following startle.

Unlike response times which, except for the initial task transition time, were largely unaffected by startle, the frequency of incorrect responses (representing errors in information processing) was found to be significantly greater in the startled than in the nonstartled group during the first minute following stimulation. This finding is in general agreement with the findings of Vlasak (1969) and Woodhead (1959, 1969) mentioned earlier, that information processing may be impaired during recovery from startle for periods ranging from 17 sec to over 30 sec. Woodhead (1969) has noted that 30 to 60 sec is the period that it generally takes for autonomic responses such as heart rate to recover to approximate prestimulus levels following startle and that it may not be mere coincidence that this corresponds to the recovery period of cognitive performance.

There was no evidence that startle affected frequency of errors or mean performance on either the SR task or on the radar task subsequent to the first minute following stimulation. Since neither heart rate nor conductance level differed among the groups during these subsequent periods of SR and radar performance, it may be concluded that both the physiological and performance effects of startle are largely confined to the initial 1-min period following startle stimulation.

FIELD STUDIES OF RESPONSE/RECOVERY TO STARTLE

It would be desirable to compare laboratory findings of performance recovery from startle with the findings of comparable studies conducted in the field. Unfortunately, such comparisons are few because of the paucity of published findings. In one of the few field studies of which I am aware that specifically investigated the effects of startle on performance, Ziperman and Smith (1975) compared the extent of disruption of driving behavior produced by unexpected air-bag deployment with that resulting from hood fly-up. Fifty-one male and female drivers ranging in age from 19 to 74 years were tested. Although air-bag deployment, accompanied by a shot-like sound, was experienced as being considerably more startling than hood fly-up, both types of events produced similar, marked changes in heart rate, blood pressure, and skin conductance. In spite of pronounced subjective and physiological evidence of startle, drivers apparently retained control of the test vehicle and were reported to be lucid on questioning less than 10 seconds after cushion deployment. As stated in their paper, "The average steering-wheel rotation was 85 degrees during hood fly-up and 72 degrees during cushion deployment. This degree of steering-wheel rotation would correspond to approximately 3 to 4 degrees at the tire. In combination with the lateral-deviation data, it shows that adequate steering control can be and is maintained in the startle modes tested" (p. 439). Although the effects of these startling events might appear to be less than one might have expected, it should be noted that the actual time-course of performance recovery cannot be determined from the data as reported in this study. There is no indication, however, that the duration of performance disruption found by Ziperman and Smith would differ appreciably from that found in our laboratory studies.

CONCLUSIONS

If we combine the results of all studies considered thus far, certain generalizations concerning response/recovery following startling events can be made:

1. Simple, voluntary responses to startling stimuli or events can generally be made within 1 to 3 sec following stimulation (Sternbach, 1960a; Thackray, 1965). In this regard, mean time to respond to a startling stimulus may not differ appreciably from mean time to respond to an unexpected event or stimulus that is simply surprising. It is likely, however, that the range of response times to the former type of event will significantly exceed the range of response times to the latter type of event (Thackray, 1965; Thackray and Touchstone, 1983).

2. More complex perceptual-motor behavior, such as that requiring continuous psychomotor control, is likely to show maximum disruption during this same 1- to 3-sec period (May and Rice, 1971; Thackray and Touchstone, 1970, 1983; Vlasak, 1969; Ziperman and Smith, 1975), although significant, but lesser, disruption may still be present for up to 10 sec following stimulation (Thackray and Touchstone, 1970).

3. Evidence from several studies suggests that the ability to process information may be impaired for 17 to 60 sec following the occurrence of a startling event (Thackray and Touchstone, 1983; Vlasak, 1969; Woodhead, 1959, 1969).

4. Individual differences in the magnitude of performance impairment following startle appear (a) directly related to physiological reactivity to startle (Sternbach, 1960a; Thackray, 1965; Thackray and Touchstone, 1970) and (b) inversely related to level of prestartle task proficiency (Thackray, 1965; Thackray and Touchstone, 1970; Vlasak, 1969).

In order to evaluate the relevance of the above laboratory and field findings of response/recovery following startle to behavioral response following real-life emergencies, it is important to recognize that unexpected and traumatic emergency situations in real life probably involve at least two phases. The first phase, which could be termed a "shock phase," constitutes the initial reaction. In this phase, the individual attempts to respond with immediate behaviors that are intended to cope with or rectify the unexpected event. While the behaviors employed may appear to be irrational and actually worsen the situation, this is clearly not the intent. With some individuals, behavior seems to become suspended (affective immobility or "freezing"), although numerous studies of response to disaster (e.g., Singer, 1982) suggest that this type of response is the exception rather than the rule. When it does occur, it appears to be a rather temporary or momentary response. In some emergencies, the shock phase is followed by a second phase which could be termed an "evaluative phase." This phase occurs if the emergency situation has not been resolved during the intial shock phase and is characterized by an emerging perception or evaluation of the situation in terms of the individual's ability, or lack of ability, to cope with the emergency. It is during this phase that panic, if no solution or escape seems possible, may occur. However, panic, like affective immobility, also appears to be a relatively infrequent form of disaster response (Singer, 1982).

If one is willing to accept that the emotional/physiological response to startle can serve to at least approximate the initial shock phase of traumatic, real-life emergencies, then findings of laboratory studies of performance recovery following startle may have relevance in predicting the time course of behavioral recovery following such events and may assist in our understanding of some of the extreme reactions displayed by individuals in real-life emergency situations. As we have noted, laboratory studies have isolated several individual difference variables (autonomic reactivity and level of prior task proficiency) that appear to be correlated with performance recovery from startle. The first of these, autonomic reactivity, suggests that inherent, constitutional factors undoubtedly play some role in startle recovery; the second variable, task proficiency or skill level, would suggest that some of the performance disruption following startle may be amenable to training. Research is needed, however, to determine the extent to which individual differences in response/recovery found in laboratory studies of startle can serve as useful predictors of disruption/recovery following simulated emergencies that closely approximate real-life situations.

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